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CITATION:

Onuki, Akira ...[et al]. 17. MODULATED PATTERNS AND PINNING EFFECT IN PHASE-SEPARATING ALLOYS. 物性研究 1990, 54(4): 323-323

ISSUE DATE:

1990-07-20

URL:

<http://hdl.handle.net/2433/94104>

RIGHT:

17. MODULATED PATTERNS AND PINNING EFFECT IN PHASE-SEPARATING ALLOYS

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A Ginzburg-Landau approach has recently been presented to analyze elastic effects in phase-separating alloys [1]. We obtain a closed description of the composition c only by eliminating the elastic field from the mechanical equilibrium. The elastic contributions to the effective free energy are (i) a long-range interaction due to the cubic anisotropy, (ii) a dipolar one due to external stresses, and (iii) a long-range one due to elastic modulus difference between the two phases. The first two are bilinear in c leading to anisotropic modulated patterns as examined in [2]. Figs.1~3 are typical examples of microstructures.

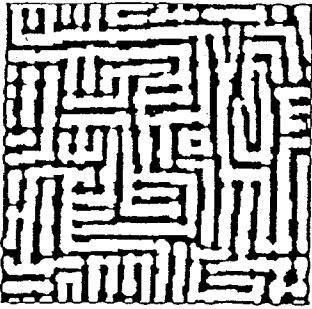


Fig.1 Cubic anisotropy only

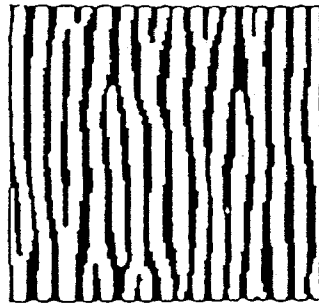


Fig.2 Cubic + uniaxial stress

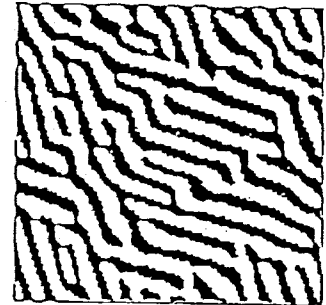
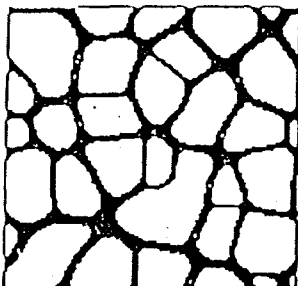
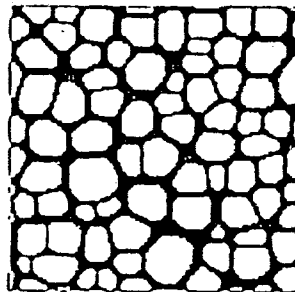
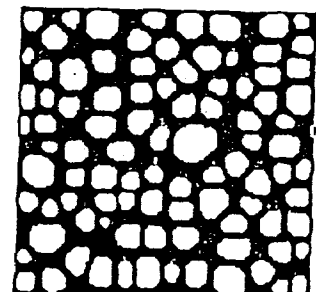


Fig.3 Cubic + shear stress

The third interaction, cubic in c , is minimized if softer domains are anisotropically deformed and if harder ones assume spherical shapes. (i) It causes shape bifurcations of a softer domain into a plate, (ii) gives rise to Eshelby's pairwise interaction among separate domains, and (iii) can freeze the coarsening at intermediate stages. In such pinned states harder domains take compact shapes and are isotropically dilated, while softer domains are anisotropically deformed and percolated wrapping the harder ones. Examples of almost pinned states are given below for three values of the volume-fraction ϕ_s of softer domains. Isotropic elasticity is assumed.

Fig.4 $\phi_s = 30\%$ Fig.5 $\phi_s = 50\%$ Fig.6 $\phi_s = 70\%$

- (1) A. Onuki, J. Phys. Soc. Jpn. 58, 3065, 3069 (1989).
- (2) H. Nishimori and A. Onuki, Phys. Rev. B, July 1, (1990).